Green plastics: analysis of a firm's sustainability orientation for innovation

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Abstract

This study aims to evaluate the orientation towards sustainability for a company's innovation project, grounded on three aspects: the importance of the triple bottom line dimensions; the stakeholders' engagement; and the nature of competencies necessary to this innovation. In order to do achieve our objective, we have gathered data from a case study of the green plastic project in Braskem, the major chemical company in Brazil and in America, and one of the biggest biopolymers producers worldwide. Thus, the study addresses the following propositions: P_1: Sustainability-oriented innovation must have also environmental and social criteria, besides economic criteria; P_2: Sustainability-oriented innovation has multiple stakeholders-related criteria selection, besides own company shareholders; and P_3: Sustainability-oriented innovation projects demand major presence of competencies if compared to traditional ones. The main results show the prevalence of environmental indicators, the very importance of value chain and also the knowledge as a basis for sustainability-oriented innovation.

Key words: Sustainability; Innovation; Green Plastic

Resumo

O objetivo do estudo é avaliar a orientação para a sustentabilidade de um projeto de inovação, fundamentando-se em três aspectos: a importância das dimensões do triple bottom line; os stakeholders envolvidos; e a natureza das competências necessárias para essa inovação. Analisa-se o caso do projeto do plástico verde da Braskem, a maior empresa química do Brasil e da América, e uma das maiores produtoras mundiais de biopolímeros. Assim, busca-se acessar as proposições: P1: A inovação orientada para a sustentabilidade deve atender critérios ambientais e sociais, além do econômico; P2: A inovação orientada para a sustentabilidade deve atender a critérios multistakeholders, além dos acionistas; e P3: A inovação orientada para a sustentabilidade demanda maior presença de competências se comparado a projetos tradicionais. Os principais resultados apontam a predominância dos indicadores ambientais, a importância da cadeia de valor, e o conhecimento como base para a inovação orientada à sustentabilidade.

Palavras-chave: Sustentabilidade; Inovação; Plástico verde

1. Introduction

For the last decades much has been discussed about natural and social problems all over the world and what should be the roles for organizations in eliminating or mitigating these issues. Along these discussions, sustainability has become one of the most important topics in management, regardless the different businesses or industries involved. Regarding sustainability, two main aspects should be emphasized here: first, as its own nature reminds us, sustainability is related to the future and to preserving the rights for future generations to have the same access to resources as we do nowadays (WCED, 1987); and, second, naturally, the use and development of technology could help mankind to achieve this desired situation in the forthcoming years, by leveraging emergent changes such as sustainability-oriented innovation (PORTER; VAN DER LINDE, 1995; EPSTEIN, 2008) or a diverse marketing orientation from the traditional approaches (HART; MILSTEIN, 2003; HART, 2007).

In this fashion, some sustainability aspects can be highlighted: (i) the fundamental concepts derived from a sustainable perspective is that organizations should pursue not only the economic bottom line but three (ELKINGTON, 1997; HARRIS; WISE; GALLAGHER; GOODWIN, 2001), adding both social and environmental dimensions to the economic to be measured as firm's performance; (ii) organizations should manage its impacts on (and from) their stakeholders, parties that are being affected by organizational performance (FREEMAN, 1984; DONALDSON; PRESTON, 1995; FROOMAN, 1999; 2002; CARROLL; BUCHWOLTZ, 2000); and (iii) innovation processes require the joint use of competencies: both the existent internally (exploitative), added to new competencies for the firm (explorative) in order to be effective (MARCH, 1991; DANNEELS, 2002).

Given to their omnipresence in our daily life and growing economic importance, plastics have been in the center of an intense debate for their non-renewable nature and long decomposition period. Bio plastics, environmentally friendly plastics or green plastics emerge as possible solutions for this issue. Thus, the study will address the following propositions: P1: Sustainability-oriented innovation must have also environmental and social criteria, besides economic criteria; P2: Sustainability-oriented innovation has multiple stakeholders-related criteria, besides own company shareholders; and P3: Sustainability-oriented innovation projects demand major presence of competencies if compared to traditional ones;

2. Theoretical background

Sustainability issues have been gaining importance for the last decades. Several authors have emphasized the positive results of including sustainable practices to management, such as sustainability-oriented innovation (PORTER; VAN DER LINDE, 1995; EPSTEIN, 2008; PRAHALAD,; HART; MILSTEIN, 2003; HART, 2007; NIDOMOLU; PRAHALAD; RANGASWAMI, 2009).

In this fashion, companies have been turned into key elements in this debate since they are holders of great economic, social and political power, and may influence the context in which they act (HART, 2007). Furthermore, Hart and Milstein (2003) emphasize that a sustainable company is the one that contributes to sustainable development while creates, simultaneously,

economic, social and environmental benefits, what brings a new perspective of management and behavior to companies, acting in a sustainable basis. Thus, sustainability means operating a business in a way that acknowledges the needs and interests of other parties (community groups […] and that does not fray but rather reinforces the network of relationships that ties them together" (SAVITZ; WEBER, 2006; pp. x-xi).

One of the fundamental concepts derived from a sustainable perspective is that organizations should pursue not only the economic bottom line but also adding social and environmental dimensions to their performance (ELKINGTON, 1997; HARRIS; WISE; GALLAGHER; GOODWIN, 2001; SAVITZ; WEBER, 2006; PAVA, 2007). Thus, the concept of "triple bottom line" (3BL) holds three distinct dimensions: (i) economical – a sustainable economic system should be able to produce products and services in a continuous way, without causing tributary or financial problems to the several participants in its value chain; (ii) social – a social sustainable system reaches social fairness in creating income and opportunities, through social services, like healthy and education, and an equal treatment to all of its members; and (iii) environmental – an environmental sustainable system do not compromise the resources sources, renewable or not, making use of them in a parsimonious way, besides try to keep the biodiversity, the stability of the atmosphere and others ecosystems functions (HARRIS; WISE; GALLAGHER; GOODWIN, 2001, pp. xxix).

Although there have been some disagreement on the triple bottom line concept (NORMAN; MACDONALD, 2004; NORMAN; MACDONALD, 2007), its use has increased since its first appearance (ELKINGTON, 2001). In short, 3BL would be "[…] a metaphor to remind us that corporate performance is multi-dimensional" (PAVA, 2007, pp. 108), or in other words, "the triple bottom line captures the essence of sustainability by measuring the impact of an organization's activities on the world" (SAVITZ; WEBER, 2006, pp. xiii).

Thus, a sustainability-oriented company would be the one that continues develops by taking into consideration the economic, social and environmental dimensions of its processes and performance.

So, it is possible to formulate the following:

> *Proposition 1: Sustainability-oriented innovation must have also environmental and social criteria, besides economic criteria.*

One concept highly related to sustainability is the idea of stakeholders. According to its classical definition (FREEMAN, 1984, pp. 46), one stakeholder is "any group or individual who can affect or is affected by the achievement of the organization's objectives". Regardless the adopted definition, it is possible to perceive a huge number of stakeholders for every specific organization. Nevertheless, as Freeman (1984) points out, there is a necessity for legitimacy of these stakeholders regarding to the organization, and vice versa (FREEMAN, 1984; MITCHELL; AGLE; WOOD, 1997), with the consequently split in legitimate and generic stakeholders, and each one of them with different levels of influence, which should be stressed in a Sustainability-Oriented Portfolio Management Model.

Besides that, there will be a large set of variables that influence the relationships among stakeholders and firms, such as industry, size, location and others (FREEMAN, 1984). From the identification of the legitimate organizational stakeholders, it is possible to look at them as a part – and an object – of the strategy of the firm. So, each stakeholder-organization relationship should be managed in a strategic approach (FREEMAN, 1984; FROOMAN, 1999; 2002; BUYSSE; VERBEKE, 2003; FERNANDEZ-GAGO; ANTONIN, 2004).

Organizations should manage their impacts on stakeholders and also deal with stakeholders influence on them (FREEMAN, 1984; DONALDSON; PRESTON, 1995; FROOMAN, 1999; 2002; CARROLL; BUCHWOLTZ, 2000). Thus, a Sustainability-Oriented firm would be the one that continuously obtains value creation processes that fulfill stakeholders' expectations, through financial and competitive success, social legitimacy and efficient use of natural resources (FIGGE; SCHALTEGGER, 2000 apud PERRINI; TENCATI, 2006). According to this, it is possible to conceive the following proposition:

> *Proposition 2: Sustainability-oriented innovation has multiple stakeholders-related criteria selection, besides own company shareholders;*

Since Schumpeter's studies, in 1940's, much has been discussed about the need for renovation in companies. After many studies done, it is known that companies can make new products based on the internal existent competencies or through new competences that should be embedded. This dichotomy idea leads to the definition of exploitation, the former case, and exploration, the last (Danneels, 2002), following the terms created by March (1991).

One strategic renewal theory should recognize that in order to a firm maintain the adaptability to its changing environment, it is required the joint use of competencies: both the existent internally (exploitative), added to new competencies for the firm (explorative) (MARCH, 1991; DANNEELS, 2008).

Thus, the firm's ability to adapt to new contexts, lay on the second order competences, called explorative learning competences, that allow a firm to identify, explore and embed new technological or market-related competences, leading to a renovation on competences portfolio in a general way (MARCH, 1991) or in specific area, such as marketing and Resource and Development (R&D) (DANNEELS, 2008). Therefore, the presence of a second order competence would mitigate the risk of historical dependencies, i.e., the stagnation in past consolidated competencies, which could block the orientation to new products and markets, obstructing the renovation. (DANNEELS, 2002).

In that way, it is crucial to search for new competences through explorative learning, combining them with the exploitative competences available internally, making it possible to one firm to become one ambidextrous organization – i.e., both exploitative and explorative. Danneels (2002) has achieved empirical support for that reasoning, through multiple case analyses of five Business to Business (B2B) companies belonging to a high tech sector, varying the age, size and diversification degree. He has verified the relationship between companies' product innovation dynamics and the missing competences for each development evolutionary stage of the firm.

Danneels (2002) also has discussed the projects characteristics depending on the nature of the innovation, as shown in the Table 1.

Table 1: **Projects characteristics depending on the nature of the innovation**

Characteristics	**Nature of Innovation**			
	Pure Exploitation	**Leveraging market competence**	**Leveraging technological competence**	**Pure Exploration**
Market potential assessment	Relatively easy	Relatively easy	Relatively difficult	Difficult
Technological feasibility	Relatively easy	Relatively difficult	Relatively easy	Difficult
Influence from the current customers	Strong	Strong	Weak	Weak

Source: adapted from Danneels (2002)

Thus, to balance between the exploration and exploitation, it would be interesting to maintain a set of organizational activities, each of which contributes to a particular type of corporate renewal in the exploration-exploitation continuum (BURGELMAN; SAYLES, 1986; KEIL, 2002).

Accordingly to Shenhar and Dvir (2007), decision making process in projects comprise several activities, such as the proper project selection and its managers, resources allocation, planning, risk management, management style, organizational structure, processes and management tools. The authors sustain that projects should be treated adaptively, taken into consideration the specific characteristics of the projects. So, it would be fundamental to identify differences among projects, classify them and select the best approach to deal with them. For this purpose, they suggest four dimensions of classification for an individual project, by assessing its degree of innovativeness, complexity, technology newness and path, shown in Table 2.

Table 2: **Nature of the innovation typology based on the competencies.**

Characteristics	Description
Innovativeness	How new the product is to its customer. Represents the uncertainty towards project's objective
Complexity	Measures the complexity of the product, the tasks and the organization.
Technology	Technological innovativeness degree of the project core technology.
Path	Represents the urgency of the project. It is related to project extent.

Source: Adapted from Shenhar and Dvir (2007)

Another important feature for analyze sustainability-orientation of a project is to identify the competences needed to its development. Based on Mills et al. (2002) categorization of resources needed for a firm, we have Table 3.

Table 3: **Competences for innovation**

Resource category	Analyzed aspect
Tangible resources	Infrastructure
	Machines and equipment
Knowledge resources, skills and experience	Labor force (number of human resources dedicated)
	Location of facilities (location relative to dealers and clients)
	Patents (intellectual property)
	Technical knowledge (know-how for carrying out the project)
	Prior experience in this kind of project
Systems and procedural resources	Inventory (capacity of keeping the level of resources needed to the project
Cultural resources and values	Culture and organizational values openness to the project requests

Source: Mills et al. (2002)

So, considering by the sustainability focus that the new challenges in the future will be associated with the development of completely new products and services embodying better environmental and social technologies, it is possible to formulate the proposition:

> *Proposition 3: Sustainability-oriented innovation projects demand major presence of competencies if compared to traditional ones.*

Thus, it would be possible to measure the orientation for sustainability for a given project related to these three propositions, according to the aims of this research, as presented in the next section.

3. Methodology

This exploratory study aims to evaluate the orientation towards sustainability for a company's innovation processes based on green plastics, based in a case study. The research is grounded on three major aspects: the relationships among the triple bottom line approach; stakeholders' influences and impacts; and the nature of innovation and needed competencies.

In order to do achieve our objective, the case study was carried out in one large Brazilian chemical company, using the single case incorporated as defined by Yin (2001). The company, Braskem, is the major chemical company in Brazil and in America, and one of the biggest biopolymers producers worldwide.

The chemical sector is known as an intensive user of technology and represents the third most important sector in Brazil in terms of GDP. The chemical sector also was elected for this study because of its B2B characteristics, ensuring the simultaneous presence of suppliers and customers in the value chain and stakeholders. This sector can be considered up to date in terms of process and product technologies in Brazil, being the leader, Braskem, the first chemical in the world to introduce the green polyethylene derived from ethanol generated from renewable sources (sugar cane). From the literature, economies of scale and scope, cumulativeness and path dependence, as well as research and commercialization capabilities, are well defined characteristics of the chemical firms (Arora and Gambardella, 1990).

We have gathered both secondary data, from company's website and reports, and primary data, performing an interview with a structured questionnaire, with four parts: (1) the sustainability indicators used in the project's monitoring; (2) the stakeholders influence in this project; (3) the general characteristics of the project and (4) which competences are needed to perform the project. The respondent is the executive responsible for the project in analysis and is the Sustainability Director. For each one of the variables a score was given and an evaluation is done in order to identify the importance of the PE Green and its relative importance if compared to regular nonrenewable projects. The rationale is shown in Table 4.

Table 4: **Dimensions and Measures for the Sustainability-Oriented Innovation**

Proposition	Construct	Dimensions	Scale
1	Triple Bottom Line (3BL) approach (Economical/ Social/ Environmental)	Importance of PE Green	Score 1 – very low to 5 – very high
		Relative importance of PE vs. Nonrenewable projects	Score 1 – much lower to 5 – much higher
2	Stakeholders influence	Importance of PE Green	Score 1 – very low to 5 – very high
		Relative importance of PE vs. Nonrenewable projects	Score 1 – much lower to 5 – much higher
3	a) Characteristics of innovation projects	Importance of PE Green	Score 1 – very low to 5 – very high
		Relative importance of PE vs. Nonrenewable projects	Score 1 – much lower to 5 – much higher
	b) Resources needed to innovation	Importance of PE Green	Score 1 – very low to 5 – very high
		Relative importance of PE vs. Nonrenewable projects	Score 1 – much lower to 5 – much higher

Source: created by the authors

Thus, it would be possible to measure the orientation for sustainability for a given project related to its orientation for sustainability, according to the aims of this research, as presented in the next section.

3. Results and discussion

3.1. The case study: Braskem Chemical

Braskem is today the largest producer of thermoplastic resin in the Americas, the largest world-wide producer of biopolymers with the green polyethylene and the largest producer of polypropylene in the United States. Its industrial units are located in Brazil, United States and Germany; countries where the company also maintains business offices and Technology & Innovation Centers. It also has commercial offices and bases in Argentina, Chile, Colombia, the Netherlands and Singapore (BRASKEM, 2013).

In 2011 Braskem had 6,477 members in Brazil and also 457 in the United States, working in 35 production units located in Brazil, the United States and Germany; it has 445 patents deposited in Brazil, the United States and Europe; and its net earnings were R$ 33.2 billion in 2011 (around USD 17 billion) (BRASKEM, 2011).

In the area of renewables, the company enlarged the partnerships with clients around Green Plastic. The unit producing ethylene derived from ethanol in Triunfo (Rio Grande do Sul) has been in operation since 2010, producing raw material for the green polyethylene. The next step will be the production of green polypropylene (BRASKEM, 2011). In the United States, as well as in Brazil, Braskem has a center for technology and innovation, fundamental to the ongoing support of Clients in the development of products and markets and to providing technical services. With Clients in more than 60 countries on five continents, Braskem supplies products that, once processed, are turned into various types of daily use items and applied in many different sectors. At present the Company has commercial offices in the United States, Argentina, Holland, Chile, Venezuela, Colombia and Singapore, the first Braskem office in Asia, inaugurated in 2011, with the objective of being closer to clients situated in Singapore, China, India, Indonesia, Korea and Japan (BRASKEM, 2011).

Braskem follows the strategies and policies defined by its holding – Odebrecht Group – and the values and principles of governance practiced are: integrity, transparency, equality, responsibility, continuity, and ethics (BRASKEM, 2013). Braskem's vision statement for 2020 is "To be the world leader in sustainable chemicals, by innovating to better serve people" (BRASKEM, 2011). Its positioning is reinforced by its seven Macro-objectives, created according to RIO+20 Conference guidelines: effect greenhouse gases; energy efficiency; hydric efficiency; chemical safety; biopolymers, post consumption, and people (BRASKEM, 2011). For each one of these aspects were created policies and initiatives, such as the biopolymers, object of this study.

3.2. Braskem's Green Plastics

The principal raw material for the petrochemical chain is naphtha derived from petroleum, a non-renewable resource. Though this is the resource first for the production of resin, Braskem has been investing in research, innovation and development of technologies for the use from

renewable raw material, which also contributes to the mitigation of climatic changes. The Company inaugurated a green ethylene plant in 2010, in Triunfo (RS), starting to produce polyethylene from ethanol of sugar-cane and becoming the biggest global producer of biopolymers, in line with its Vision 2020. The entry into this segment of renewables put the Company in contact with a new chain of supplies that of agro-business, bringing challenges such as the use of the land and respect for the rights of the workers in cane plantations. This production chain is managed through control and auditing of the ethanol Suppliers. In 2010, Braskem approved the Code of Conduct for Ethanol suppliers, that establishes sustainability criteria, including a commitment to environmental guidelines and respect for biodiversity and human and labor rights.

Today, around 85% of all the ethanol acquired for the green ethylene and ETBE plants are up to the code and, in 2011, an additional certification was adopted, that of Bonsucro, an institution with headquarters in London, England, whose certificate attests to sustainable practices in production, demanding the fulfillment of the laws, respect for human and labor rights, the preservation of biodiversity and the services of the ecosystem, besides productivity and continuous improvement of productive processes.

The year of 2011 was of training and consolidation of the project of ethylene and green polyethylene produced in Triunfo (RS) since September of 2010. As usual in the trial launching any new product in the market, necessary adjustments were made in equipment and processes, for cost-cutting and better competitiveness of the business. In 2011, the Client base for the green line grew, especially in European countries, a destination for a great part of this resin. Braskem' s Clients include, for example, Coca Cola, Nestlé, Johnson & Johnson, Tetra Pak, Danone, Natura, Chanel, Toyota Tsusho, among other corporations.

In its portfolio of products made from renewable resources, Braskem offers a wide range of polyethylene grades to meet the growing demand for more sustainable products. These grades offer a versatile range of applications, especially in the personal care, cleaning, cosmetics, food and automotive industries. Since it has the same technical properties and processability as resin made from fossil fuels, processing the green plastic does not require any new investments in equipment or technical adjustments, which represents a very important advantage for the manufacturing industry. In October 2010, Braskem announced the construction of another production unit using renewable raw materials. This time, the plant will produce green propylene, which is also made from sugarcane ethanol and will have minimum production capacity of 30.000 tons/year, with start-up slated for late 2013. This will enable the production of green polypropylene, which, in its fossil fuel version, is the second most used thermoplastic resin in the world. The green PP will complement the company's biopolymers portfolio and make possible new applications and partnerships.

The sustainable balance of green plastic shows that for each ton of green polyethylene produced, 2.5 tons of CO2 are captured and sequestered. Another advantage is that green plastic is 100% recyclable using existing processes. Because green polyethylene is a high-value-added material, its recyclability is a very important characteristic, since it allows the material to be reused innumerous times. In addition, because green PE is not biodegradable, the CO2 captured during the sugarcane cultivation process remains sequestered for the plastic's entire life cycle.

In 2011, Braskem's green PE received the highest certification from the Belgian company Vinçotte, the leading certifier of products with content of renewable origin. The analysis was based on samples from the HDPE (high density polyethylene) and LLDPE (linear low density polyethylene) families. All grades received four-star certifications, which is the highest

quality rating conferred by Vinçotte. Until April 2014, Braskem's green polyethylene will use the seal 'Ok Biobased'.

Some advantages make sugarcane a global reference among the world's renewable energy resources. Over 30 years of research and technological development in the area of sugarcane cultivation have put Brazil in a vanguard position and given it important competitive advantages. Renowned worldwide for its sustainability and efficient production, today Brazilian sugarcane is a key protagonist in the consolidation of the so-called low-carbon economy. The fuel boasts the highest reduction in greenhouse gas emissions, which are responsible for global warming and climate change. The emission of gases during its entire life cycle until the burning of the ethanol is up to 84% lower than that of gasoline. On the same comparison basis, the emissions of corn ethanol (United States) are only 30% lower than that of gasoline and 40% lower than that of beet ethanol (Europe).

In addition, sugarcane cultivation does not cause significant impacts on farming activities. Brazil uses only 1% of its arable land to produce ethanol, and of this land 80% is located in the Southeast region of Brazil. The crop can also be expanded over a vast area of degraded pastures without competing with land used for food cultivation.

Lastly, it is important to point out that sugarcane cultivation does not cause any impacts on the Amazon Rainforest. Not only does it have weather conditions that are inadequate for growing sugarcane, the Amazon is located 2,500 km away from the main sugarcane growing regions. Moreover, national and regional laws govern the cultivation and expansion of areas dedicated to sugarcane cultivation in order to preserve the existing ecosystem.

The energy balance of sugarcane shows its superiority. Data from the World Watch Institute (2006) show that sugarcane ethanol generates 9.3 units of renewable energy for each unit of fossil energy used in its production. In the case of corn ethanol (United States), the renewable energy generated by the ethanol produced is only 1.4, while for beet ethanol (Europe) this figure is of 2.0 units. This advantage of sugarcane is largely due to the fact that the Brazilian plants are self-sufficient in terms of energy, since they use the co-products from the actual process to generate bioenergy. In addition, the productivity of sugarcane is higher than that of other renewable resources. For comparison, sugarcane (Brazil) yields 6,500 ethanol liters/hectare; corn (United States) 4,200 liters/hectare; and beets (Europe) 5,500 liters/hectare.

The I'm green™ seal was created to identify products that contain Braskem's green plastic in their composition. The use of the seal is subject to the compliance with certain rules that consider the transparency of communication and compliance with international green seal rules. The main objective of these criteria is to create a strong identification that conveys credibility to final consumers, while avoiding as much as possible any association of products using Braskem' s green plastic with greenwashing practices.

3.3. Results and analysis

In this session we present the data gathered from the interview and the structured questionnaire, performed with the executive responsible for Braskem´s Directory of Sustainability. The analysis comprises the following facets: the sustainability indicators used to monitor this project; the stakeholders taken into account in this project; the characteristics of PE Green project and the competences needed for its accomplishment. For each one of the variables a score was given and an evaluation is done.

3.3.1 PE Green's GRI indicators

Economic indicators

Table 5 shows the results for the economic indicators of PE Green project. Four of the seven GRI essential economic indicators listed are used (57%). The highpoint is EC1, emphasizing the economic importance of this project. Several factors contribute to this perception. This project is aligned with the new vision of the enterprise, enphasizing green products. It has lower relative costs from raw materials compared to mineral sources and also is promising to gain market share in the new social-environmental paradigm. The incomes came from abroad are expected to be higher.

Table 5: **Economic indicators – PE Green Project**

Indicators used	Description	Score for PE Green*	PE Green Importance	Relative Score**	PE Green vs. Nonrenewable PE
EC1	Direct economic value generated and distributed, including revenues, operating costs, employee compensation, donations and other community investments, retained earnings, and payments to capital providers and governments.	4	High	4	Higher
EC4	Significant financial assistance received from government.	3	Medium	3	Equal
EC6	Policy, practices, and proportion of spending on locally-based suppliers at significant locations of operation.	3	Medium	3	Lower
EC7	Procedures for local hiring and proportion of senior management hired from the local community at locations of significant operation.	4	High	3	Equal

*Score 1 – very low to 5 – very high; **Score 1 – much lower to 5 – much higher

Environmental Indicators

Table 6 shows the results for the environmental indicators of PE Green project.

Table 6: **Environmental indicators – PE Green Project**

Indicators used	Description	Score for PE Green*	PE Green Importance	Relative Score**	PE Green vs. Nonrenewable PE
EN1	Materials used by weight or volume.	5	High	5	Higher
EN3	Direct energy consumption by primary energy source.	3	Medium	3	Equal
EN4	Indirect energy consumption by primary source.	2	Low	3	Equal
EN8	Total water withdrawal by source.	4	High	5	Much higher
EN11	Location and size of land owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas.	2	Low	3	Equal
EN16	Total direct and indirect greenhouse gas emissions by weight.	5	Very high	5	Much higher
EN17	Other relevant indirect greenhouse gas emissions by weight.	5	Very high	5	Much higher
EN19	Emissions of ozone-depleting substances by weight.	4	High	4	Higher
EN20	NOx, SOx, and other significant air emissions by type and weight.	4	High	4	Higher
EN21	Total water discharge by quality and	5	Very high	5	Much higher

	destination.				
EN22	Total weight of waste by type and disposal method.	4	High	3	Equal
EN23	Total number and volume of significant spills.	4	High	3	Equal

*Score 1 – very low to 5 – very high; **Score 1 – much lower to 5 – much higher

We notice that 12 of the 17 GRI essential environmental indicators listed are used (70.6%). The emphasis is on EN8, EN16, EN17 and EN21, what reinforces the importance of water and greenhouse gases – two of the Braskem's macro-objectives. It is interesting to notice that the location (EN11) is not as important as the others, possibly because the company had already had its plant in operation and indirect energy consumption is also lower, possibly due to the new technology in use.

Social indicators

Table 7 shows the results for the environmental indicators of PE Green project and we notice that 9 of the 25 GRI essential social indicators listed are used (36%). Despite some high scores (LA7, HR6, HR7, SO1), the importance of the PE Green project is relatively the same if compared to other projects. It gives the impression that the social policies are the same throughout the company and they do not vary accordingly to the project nature.

Table 7: **Social indicators – PE Green Project**

Indicators used	Description	Score for PE Green*	PE Green Importance	Relative Score*	PE Green vs. Non renewable PE
LA1	Total workforce by employment type, employment contract, and region.	3	Medium	3	Equal
LA7	Rates of injury, occupational diseases, lost days, and absenteeism, and number of work- related fatalities by region.	5	Very high	3	Equal
LA10	Average hours of training per year per employee by employee category	3	Medium	3	Equal
HR6	Operations identified as having significant risk for incidents of child labor, and measures taken to contribute to the elimination of child labor.	5	Very high	3	Equal
HR7	Operations identified as having significant risk for incidents of forced or compulsory labor, and measures to contribute to the elimination of forced or compulsory labor.	5	Very high	3	Equal
SO1	Nature, scope, and effectiveness of any programs and practices that assess and manage the impacts of operations on communities, including entering, operating, and exiting.	5	Very high	3	Equal
PR1	Life cycle stages in which health and safety impacts of products and services are assessed for improvement, and percentage of significant products and services categories subject to such procedures.	4	High	3	Equal
PR9	Monetary value of significant fines for non- compliance with laws and regulations concerning the provision and use of products and services.	1	Very low	3	Equal

*Score 1 – very low to 5 – very high; **Score 1 – much lower to 5 – much higher

3.3.2 PE Green's Stakeholders

Table 8 shows the results for the stakeholders taken into consideration for PE Green project, and we notice that 10 of the 14 stakeholders indicators listed are used (70.6%). The primary concern is on international consumers and clients – what is totally coherent with the company's vision – and shareholders, highlighting the economic and financial impact of this project for its investors. If compared to other projects, the emphasis are on international consumers and clients, and local suppliers, what gives an idea of the importance of the supply chain for the success of this new product. Other stakeholders such as employees, international signatories, Non-Governmental Organizations (NGOs), and local public agencies were not given a score, according to the respondent.

Table 8: **Stakeholders – PE Green Project**

Stakeholders	Score for PE Green*	PE Green Importance	Relative Score*	PE Green vs. Nonrenewable PE
Local consumers and clients	3	Medium	3	Equal
International consumers and clients	5	Very high	5	Much higher
Local suppliers	4	High	5	Much higher
International suppliers	3	Medium	3	Equal
Shareholders	5	Very high	3	Equal
Financial institutions	4	High	3	Equal
Local competitors	4	High	3	Equal
International competitors	4	High	4	Higher
Media	3	Medium	3	Equal
Government	4	High	3	Equal

*Score 1 – very low to 5 – very high; **Score 1 – much lower to 5 – much higher

3.3.3 PE Green's characteristics

Based on the following terms related to the Shenhar and Dvir (2007) model, we have the results for the characteristics of PE Green project in Table 9.

Table 9: **Characteristics for the Sustainability-Oriented Innovation**

Characteristics	Description	Score for PE Green*	PE Green Importance	Relative Score**	PE Green vs. Nonrenewable PE
Innovativeness	How new the product is to its customer. Represents the uncertainty towards project's objective	4	High	4	Higher
Complexity	Measures the complexity of the product, the tasks and the organization.	2	Low	2	Lower
Technology	Technological innovativeness degree of the project core technology.	2	Low	2	Lower
Path	Represents the urgency of the project. It is related to project extent.	3	Medium	3	Equal

*Score 1 – very low to 5 – very high; **Score 1 – much lower to 5 – much higher

Thus, we have:

- Innovativeness degree: it is considered high, since its novelty in a whole world base, being classified as "new to the world". Compared to the projects based in nonrenewable sources, the innovativeness degree is considered higher.
- Complexity degree: it is considered low, since the company was used to build the polymerization facilities. One time the process of the conversion from ethanol to ethylene

was developed in laboratories, the upscale to industrial scale was not considered complex, and even lower than the projects with nonrenewable sources, because the operation process was simplified.

- Technology newness degree: in the same direction, it was considered low, because the technology to convert ethanol to ethylene was known since the 70's. The great advance came from the development of one process to achieve higher levels of efficiency in this process, as well as the development of the new sugar cane supply chain.
- Path: the PE green project building showed similar duration from the planning phase to the facility deliver, compared to traditional projects.

3.3.4 PE Green's competences

By using the Mills et al (2002) typology on competences, the respondent classified the competences needed in PE green project in terms of presence and importance, and also in comparison to traditional projects from nonrenewable sources. The results are shown in Table 10.

Table 10: **Competences needed to the project**

Resource	Score for PE Green*	PE Green Importance	Relative Score**	PE Green vs. Nonrenewable PE
Infrastructure	3	Medium	3	Equal
Machines and equipment	3	Medium	3	Equal
Labor force – number of human resources dedicated	3	Medium	3	Equal
Location of facilities (location relative to dealers and clients)	3	Medium	3	Equal
Patents (intellectual property)	3	Medium	4	Higher
Inventory (capacity of keeping the level of resources needed to the project)	3	Medium	4	Higher
Technical knowledge (know-how for carrying out the project)	5	Very high	5	Much higher
Prior experience in this kind of project	2	Low	4	Higher
Culture and organizational values openness to the project requests	4	High	4	Higher

*Score 1 – very low to 5 – very high; **Score 1 – much lower to 5 – much higher

If compared to traditional projects on PE obtained from nonrenewable sources, it is possible to notice which were the more distinctive competences needed to perform the PE green project, as follows:

- Patents (intellectual property): after developing the process, the company has protected the intellectual property on one international basis, being the PE green patent the first one to be deposited in the world.
- Technical knowledge (know-how for carrying out the project): the lab upscale development, the multidisciplinary experts involved in the project and partnerships with Universities and ethanol institutes were considered distinctive aspects for the positive achievements.
- Prior experience in this kind of project: the path dependencies on producing plastics and doing retrofitting of industrial plants, aided the company to continuously deal with the obstacles encountered along with the development stages

– Culture and organizational values openness to the project requests: in the view of the interviewed, only the openness of culture to absorb one change of raw material source, in this magnitude, enabled the project success. Not only the culture for change was present, but also it was formalized and expressed in the company's vision, mission and main values.

4. Conclusions

As academic implications, these preliminary results indicate that several aspects of the sustainability-orientation are taken into account in the analyzed project and they occur in different degrees and also according to the company´s strategy. For the three propositions, we have the following: *P1: Sustainability-oriented innovation must have also environmental and social criteria, besides economic criteria*: the 3BL approach is taken into account, but with a predominance of environmental indicators, especially if we compare the PE Green project to others; *P2: Sustainability-oriented innovation has multiple stakeholders-related criteria selection, besides own company shareholders:* the highpoints are the shareholders and also international market and local suppliers, due to the company´s characteristics (open market), strategy (internationalization) and resources dependency (value chain); and *P3: Sustainability-oriented innovation projects demand major presence of competencies if compared to traditional ones:* the most important resource is technical knowledge, given the innovative driver of this project. Thus, we have considered the suitability of these propositions, especially if we consider the multifaceted way to determine the sustainability-orientation for innovation.

As practical implications, it is possible to point out the need for effective assessments in order to effectively evaluate innovation management. The complexity of a sustainable approach and its effective operationalization can also lead to major difficulties in assessing? the orientation for sustainability in innovative projects. The use of Global Reporting Initiative (GRI) indicators can be an easier way to do so, but specific and strategic aspects for each company may not be all covered by standardized guidelines. Besides that we could emphasize the importance of both stakeholders' strategic management and also strategic project management as critical for company's performance.

As limitations for this research it is appropriate to mention that the primary data comes from the perception of only one respondent and it is a cross data analysis. We suggest that the same data to be gathered from different sources within one company to better understand the different visions of the project in analysis.

As suggestions for future studies, it would also be important to have empirical data from other leading companies that already have sustainability-oriented projects, products and services, in order to introduce control variables for comparison among different sectors and size, or even to identify the best practices in the field. Other possibility, in the same sense, is to compare distinct innovation projects among one firm's portfolio, in one extended data base.

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